LA-UR- 95-4002
CONF-9511128--11

SEISMIC MARGINS ASSESSMENT OF THE PLUTONIUM PROCESSING FACILITY LOS ALAMOS NATIONAL LABORATORY

by

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ABSTRACT

Results of the recently completed seismic hazard evaluation at the Los Alamos National Laboratory site indicate a need to consider seismic loads greater than design basis for many structures systems and components (SSCs). DOE Order 5480.28 requires that existing SSCs be evaluated to determine their ability to withstand the effects of earthquakes when changes in the understanding of this hazard results in greater loads. In preparation for the implementation of DOE Order 5480.28 and to support the update of the facility Safety Analysis Report, a seismic margin assessment of SSCs necessary for a monitored passive safe shutdown of the Plutonium Processing Facility (PF-4) was performed.

The seismic margin methodology is given in EPRI NP-6041-SL, "A Methodology for Assessment of Nuclear Power Plant Seismic Margin (Revision 1)". In this methodology, high confidence of low probability of failure (HCLPF) capacities for SSCs are estimated in a deterministic manner. For comparison to the performance goals given in DOE Order 5480.28, the results of the seismic margins assessment were used to estimate the annual probability of failure for the evaluated SSCs.

In general, the results show that the capacity for the SSCs comprising PF-4 is high. This is to be expected for a newer facility as PF-4 was designed in the early 1970's. The methodology and results of this study are presented in this paper.

INTRODUCTION

DOE Order 5480.28 [1] requires that existing structures, systems and components (SSCs) be evaluated to determine their ability to withstand the effects of natural phenomena hazards. For existing SSCs, 5480.28 requires re-evaluation when changes in the understanding of a hazard results in greater loads. Los Alamos National Laboratory (LANL) has re-evaluated its seismic hazard. Results of this study indicate that seismically induced loads will be significantly greater than those for which the SSCs for the Plutonium Processing Facility (PF-4) at Technical Area 55 (TA-55) were designed.

In preparation for 5480.28 and in support of an update to the Safety Analysis Report, a seismic margin assessment of the Plutonium Facility was made. The SSCs evaluated were divided into two groups. The first group includes those necessary for a monitored passive safe shutdown. The second group includes SSCs necessary for worker safety.

For the systems associated with the monitored passive safe shutdown and for some of the systems associated with worker safety, the evaluation considered both the identification of seismic vulnerabilities and the calculation of seismic capacity. For the other SSCs considered for worker safety, the evaluation considered only the identification of seismic vulnerabilities. Only the SSCs for which seismic capacity was determined are discussed here.

A seismic margins assessment (SMA) was conducted to determine the seismic capacity of the facility to achieve a monitored safe shutdown and systems important to worker safety. The intent of the

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seismic margins methodology is to demonstrate margin above the design basis earthquake for which there is a high confidence of low probability of failure (HCLPF). For this evaluation, Electric Power Research Institute report EPRI NP-6041-SL [2] was used. This methodology selects a Review Level Earthquake (RLE) larger than the design basis as a target "margin" earthquake. Many components were screened from review as having HCLPF capacities for components greater that the RLE. The HCLPF capacities for components not screened were calculated using a conservative deterministic failure margin (CDFM) methodology. The resulting seismic margin for a given function or system was taken to be the lowest HCLPF capacity calculated for those components required for the function or system.

The results of the SMA were then extended to estimate the annual probability of seismic induced failure for comparison to criteria established by DOE 5480.28 [1] and DOE STD 1020 [3]. The performance goals established by these documents is shown in Table 1. A probabilistic approach was used to determine the performance achieved by the SSCs evaluated in the SMA.

Table 1 - Performance Goals and Categories [1] [3]

Performance Category	Seismic Hazard Exceedance Level	Seismic Performance Goal
PC0	N/A	N/A
PC1	2.00E-03	1.00E-03
PC2	1.00E-03	5.00E-04
PC3	5.00E-04	1.00E-04
PC4	1.00E-04	1.00E-05

SEISMIC HAZARD

Woodward Clyde Federal Services (WCFS) [4] has recently completed an evaluation of the seismic hazard at the LANL site using "state of the art" technology. This study has estimated the site-specific ground motions using both probabilistic and deterministic methodologies.

The study has established probabilistic seismic hazard curves for the peak horizontal ground acceleration for TA-55. The peak horizontal ground accelerations at the mean annual exceedance probabilities specified in DOE Standard 1020-94 [3] for the various Performance Categories (PCs) can be determined from the mean hazard curve. The peak horizontal accelerations for TA-55 for the various PCs are shown in Table 2. The site-specific response spectra associated with these peak horizontal ground accelerations are shown in Figure 1.

Table 2 - Horizontal PGA's at TA-55 [4]

PC	Annual Probability of Exceedance	Mean Horizontal PGA (g)
1	2.00E-03	0.15
2	1.00E-03	0.22
3	5.00E-04	0.30
4	1.00E-05	0.56

Because the WCFS study was not complete at the beginning of the SMA, the review level earthquake (RLE), was defined using non-site specific criteria. The RLE used in the seismic margin assessment of PF-4 was a median spectral amplification, NUREG/CR-0098 [5] soil response spectrum anchored to a peak ground acceleration of 0.50 g. The RLE is shown in Figure 2. (Figure 1 compares the spectral shape of the RLE to that established by the WCFS study.) This RLE is referenced for use in SMA evaluations of power plants in the western United States but away from the California Coast [6].

The RLE response spectra was used in each horizontal direction as well as the vertical direction. Although it is standard practice to use 2/3 the value of the horizontal accelerations in the vertical direction, preliminary results of the WCFS study stated that the presence of the near field faults indicates that use of this value may not be sufficiently conservative. For this reason, the value of the vertical accelerations was set equal to the horizontal accelerations.

SEISMIC EQUIPMENT LIST

SSCs required to bring the plant to a monitored safe shutdown and to enhance worker safety were selected through a review of the 1978 Safety Analysis Report, systems descriptions, and process flow diagrams. Interviews with PF-4 personnel knowledgeable of the required systems provided additional information. In developing the seismic equipment list, it was assumed that offsite power would be lost following an earthquake. No other extraordinary events or accidents were postulated to occur other than the RLE.

SSCS REQUIRED FOR SAFE SHUTDOWN

The safe shutdown philosophy provides for confinement of hazardous materials in the event of

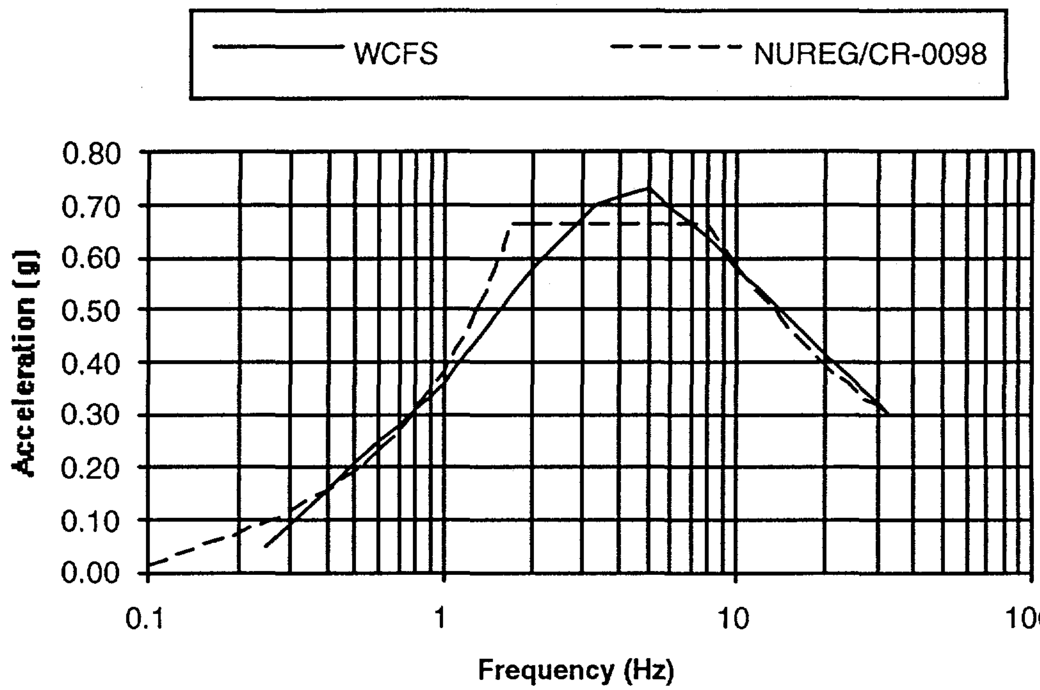

Figure 1 - WCFS Equal Hazard Response Spectrum [4], [5]
(Mean Equal Hazard Spectrum from WCFS is shown with NUREG/CR-0098 median soil site response spectrum anchored to a peak ground acceleration of 0.30 g for comparison purposes. Both spectra are shown at 5% of critical damping.)

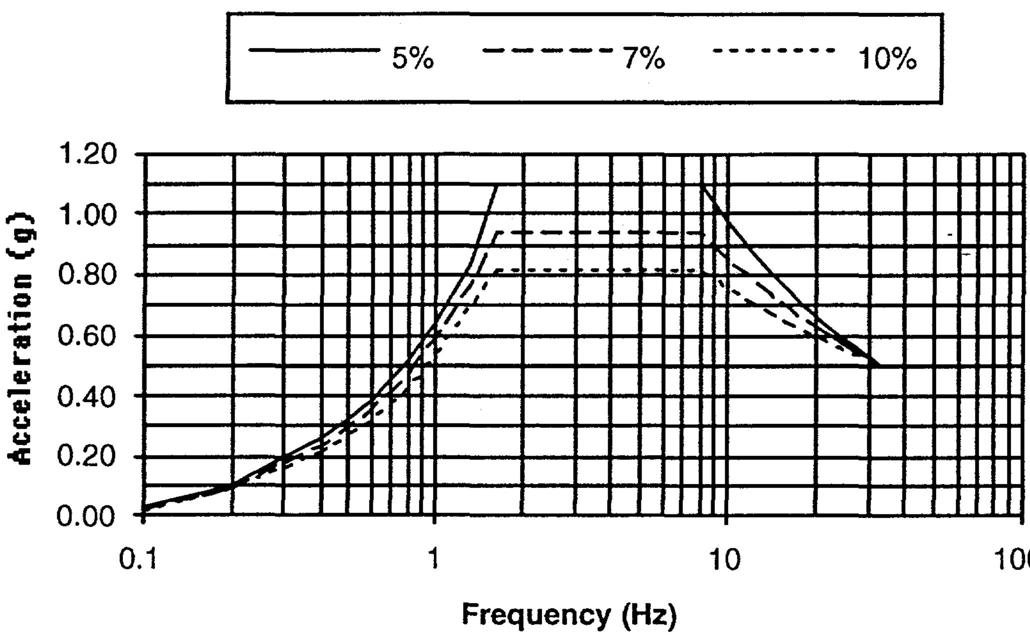

Figure 2 - Review Level Earthquake Response Spectra [5]
(NUREG/CR-0098 median soil site response spectrum anchored to a peak ground acceleration of 0.50 g)

Design Basis Accidents including earthquakes. During a passive safe shutdown, the ventilation fans will be shut down, the supply system will be closed off, the exhaust valves will be opened and the building will be allowed to breathe through the exhaust filter plenums. Hazardous material is confined by the building structure, the filter plenums and the ductwork from the plenums to the stacks. An active shutdown mode, requiring electrical and mechanical systems to maintain negative pressure on the building is not part of this philosophy.

The systems required for confinement of hazardous materials include the PF-4 structure, the air intake system and the ventilation exhaust system. The concrete walls and basement and roof slabs of the structure will continue to provide confinement following a seismic event provided concrete cracking is kept to a minimum. Therefore, the PF-4 structure was included in this evaluation.

The safe shutdown philosophy requires that the air intake valves close and the building breathe through the exhaust filter plenums. Therefore, the air intake valves must be operational following the earthquake and were included in the evaluation. In the event the intake valves fail to close, building exhaust must be filtered through the intake filter plenums and ductwork. Therefore, these SSCs were also included.

The ventilation exhaust systems include the Zone 1 Exhaust Filter Plenums, the Zone 2 Bleedoff Filter Plenums and the Zone 3 Exhaust Filter Plenums, the ductwork (including the structural integrity of the fans) from the plenum to the stacks, and the isolation valves. These SSCs were all included in the evaluation.

For the SMA, the passive safe shutdown was extended to include monitoring of exhaust air. Therefore, the stack monitoring system along with required support systems were included. The systems required for monitoring filtered releases include stack monitors, data acquisition and uninterruptable power supply. The stack monitors include continuous air monitors, fixed head filters, emergency vacuum pumps and flow transmitters. The facility control and data acquisition system consists of two redundant computers, twenty three field multiplex units, two central control unit multiplexes, two moving head disc memory units, data terminals, consoles with I/O terminals/printers and other miscellaneous components. The UPS consists of seven main sections: two battery chargers, two inverters, a three-position static semiconductor switch, an AC bypass switch, and a sixty cell 1800 A-hr battery common to both 37.5 kVA rectifiers/chargers and inverter units.

SYSTEMS TO ENHANCE WORKER SAFETY

Systems necessary to enhance worker safety were determined through discussions with safety analysis personnel at TA-55. The systems included in the SMA portion of the seismic evaluation of the Plutonium Facility were the auxiliary power, primary confinement, and fire suppression.

The UPS system can provide power necessary for stack monitoring and data acquisition for a time period ranging from 2 to 10 hours. Offsite power may be lost for periods extending past the life of the UPS. In order to provide monitoring beyond the 2 to 10 hours, an auxiliary power source is needed. At PF-4, this auxiliary power may be provided by either the motor diesel generator or through a trailer mounted generator brought to the site. TA-55 is equipped with a 750 kVA diesel generator that will supply auxiliary power for a period of 13 hours at the generator's full rated load. The generator system consists of a single 750 kVA diesel generator unit, a local control panel, a remote control and associated field multiplex unit, an air start unit, two battery starting units, a 200 gallon day tank, and the circuit breakers and switching devices required to deliver load to the UPS.

Primary confinement of radioactive materials is provided by glove boxes, process vessels (pencil tanks) and the vault storage units. The glove box system is comprised of the glove box units, the trolley tunnel, and the exhaust filtration and ducting. In addition, certain process vessels and chemical storage tanks are located in PF-4 outside of glove boxes. Because of this, the loss of vessel contents due to either gross structural failure, or failure of attached lines would place workers at risk. Thus, the integrity of the selected process vessels was included in this study.

The north and south vault areas of PF-4 are used for storage of special nuclear material. The majority of the material is contained in DOT approved shipping containers, and is stored on shelving, drawers or tanks. During an earthquake, there is potential for the containers to fall, and possibly contaminate the vault area. Because of this, the vault storage racks are important to worker safety.

The fire suppression system consists of a water supply and storage system, a fire water pumping and distribution system, automatic sprinklers, a maintenance fire system, Halon gas systems, manual hose rack systems, and hand-held fire extinguishers. In addition, special suppression systems used in selected glove boxes include magnesium oxide, graphite powder, or argon for extinguishing or preventing plutonium fires.

BUILDING STRUCTURAL ANALYSIS

The PF-4 structure was analyzed to determine its ability to resist the review level earthquake and to develop seismic input for systems and components mounted in the structure. The analysis was divided into two tasks. In the first task, a fixed base model was analyzed using a modified input response spectrum to account for frequency shifts due to soil-structure interaction. This model was used to estimate the seismic demand loads on the structure for use in the seismic margin calculations.

The performance goal of the PF-4 structure is to provide confinement of hazardous materials following a seismic event. Therefore, only minor cracking of the shear walls and diaphragms is allowed. In the SMA analysis this was done by limiting the amount of inelastic behavior. For this structure, essentially no inelastic response was allowed by setting the inelastic demand factor (F_μ) equal to 1.0 and limiting the damping on the structure to 7 percent of critical.

In the second task, a soil-structure interaction (SSI) analysis was performed to develop soil springs and associated damping constants. A time history analysis of the soil spring model was then performed. Synthetic input motion that produced a response spectrum matching the RLE was used. This analysis was used to develop in-structure response spectra for use in the calculation of seismic demand loads on the systems and components attached to PF-4.

SCREENING WALKDOWNS

Walkdowns for the SSCs selected for the monitored passive safe shutdown and for enhancement of worker safety were conducted in accordance with a procedure developed from [2], [7] and [8]. The objectives of the walkdowns were to screen rugged items (those requiring no further evaluation), to identify equipment and systems that were clearly seismically deficient and to collect data for items not screened. Items judged to have HCLPF capacities in excess of the RLE were screened from further review.

For groups of components with similar load and resistance mechanisms, bounding case analyses were performed to estimate a HCLPF capacity representative of all components in the bounding case sample. Bounding case samples were selected in the walkdowns and information was collected for each bounding case. Each bounding case was selected to be representative of all components in the sample. Examples of component sets amenable to bounding case analysis include valves, fans, ducts, plenums, glove boxes, etc.

The components that were selected for review were first compared to the screening guidance given in [4] to first determine if they could be screened from further review. Items screened from further review required a consensus agreement by the engineers performing the walkdowns. Walkdowns were then conducted on components that could not be screened in order to collect information for subsequent analysis. Walkbys were performed on those components that were screened or judged to be bounded by like components to ensure that unique installations did not jeopardize seismic adequacy. The walkbys were conducted based on guidance contained Appendix A of [2].

In general, the walkdown teams found that the seismic capacities for components reviewed was high. This is to be expected for a newer facility, with a relatively high seismic design basis. However, several general concerns were noted. These concerns include the presence of vibration sensitive relays and pressure switches, suspect anchorage, and seismic interaction. Anchorage evaluations were performed for those components for which there were concerns.

HCLPF CAPACITY CALCULATIONS

HCLPF capacity calculations were performed on those components that could not be screened as having HCLPF capacities in excess if the RLE. The conservative deterministic failure margin (CDFM) approach as presented in [2] was used in performing the HCLPF capacity calculations. The general criteria used in the CDFM approach are outlined below.

The CDFM approach consists of the following steps: 1) For the specified RLE, the elastic computed response of structures and components mounted thereon should be defined at the 84% non-exceedance probability; 2) Capacities for most components should be defined at about the 98% exceedance probability; 3) The capacity for components typified by brittle failure modes should be defined at about the 99% exceedance probability; 4) Inelastic distortion associated with a Demand/Capacity ratio greater than unity are permissible; and, 5) The seismic demand to capacity ratio should be less than the inelastic energy absorption factor, F_{μ}.

Because of the conservatism introduced at the various steps, the result is a high-confidence-of-a-low-probability-of-failure (HCLPF) capacity when the criteria in step number 5 is satisfied.

PF-4 STRUCTURE HCLPF CAPACITY

The seismic demand loads to the critical elements of PF-4 were determined by a response spectrum analysis. The element HCLPF capacities were determined using the CDFM approach. For failure modes evaluated by analysis, a seismic capacity evaluation requires estimates of material strength, static capacity, and inelastic energy absorption.

For the PF-4 structure, the minimum specified strengths for the concrete and reinforcing steel are used to determine capacities. For concrete, the minimum compressive strength at 28 days is used, f'c = 4,000 psi. For reinforcing steel the yield strength is fy = 60,000 psi.

The static capacity estimates are based on Uniform Building Code (UBC) [9] and American Concrete Institute (ACI) [10] ultimate strength requirements for all failure modes investigated except for the in-plane shear strength of concrete walls and diaphragms. Studies have shown that the shear strength of low-rise concrete shear walls are conservatively predicted by UBC and ACI code provisions. This is particularly true for walls with height to length ratios of about one or less. For in-plane shear, the capacity was determined in accordance with Appendix L of [2].

As noted in the discussion of the structure analysis, the inelastic demand factor was limited to 1.0.

HCLPF CAPACITY OF SSCS NOT SCREENED

The HCLPF capacity of those SSCs not screened were computed using the CDFM methodology outlined above. In-structure response spectra generated at the RLE were used to define demand. Capacities were defined at either the 98% or 99%, depending on the failure mode. A limited amount of inelastic energy absorption was generally allowed.

ACCEPTANCE CRITERIA

DOE Order 5480.28 requires that SSCs be designed and constructed to withstand the effects of natural phenomena hazards. The target safety levels for SSCs subject to NPH are given in terms of performance goals. The performance goal is defined as the acceptable annual probability of failure.

For SSCs to be acceptable, it must be demonstrated that three is a sufficiently low probability of damage/failure of those SSCs consistent with established performance goals. These performance goals are shown in Table 1 and are a function of SSC performance category. The SSCs evaluated as part of this study were classified in accordance with DOE STD 1021-92 [11]. For the SSCs discussed in this paper, all were assigned to Performance Category 3.

A probabilistic approach [12] was used to determine the performance goals achieved by existing SSCs as part of the SMA of PF-4. By this approach, the probability of unacceptable performance is obtained by a convolution of the seismic hazard and SSC fragility curves. The seismic hazard curve is obtained from the result of the WCFS study. The SSC fragility curves are estimated using methodology presented in [13].

RESULTS

Systems generally are made up of several components. A system level HCLPF is defined by the component with the lowest HCLPF capacity. Similarly, functions which must be maintained on a plant level are made up of many systems and components. A plant level HCLPF is defined by the weakest system or component. Plant level HCLPF capacities are developed for the passive safe shutdown and for the monitoring of filtered releases. System level HCLPF are determined for the auxiliary power system, primary containment of radioactive materials and fire suppression.

A summary of the resulting HCLPF capacities, along with a description of the controlling failure mode is presented in Tables 3, 4 and 5. Table 3 summarizes the HCLPF capacities of SSCs necessary for a passive safe shutdown. Table 4 summarizes the

HCLPF capacities of SSCs necessary to monitor the safe shutdown. Table 5 summarizes HCLPF capacities for selected SSCs necessary to enhance worker safety.

For SSCs placed in Performance Category 3, the performance goal for annual probability of seismic induced failure is 10^{-4} [1]. For HCLPF capacities in excess of 0.31g, this performance goal is met.

For existing SSCs not meeting the Reference 8 criteria, Section 1.3 of DOE STD 1020 [3] provides guidance for those which are close to meeting criteria. Because it is not cost effective to strengthen the SSC in order to obtain a small reduction in risk, it is permissible to perform such evaluations using natural phenomena hazard exceedance probability of twice the value specified for new design. For most seismic hazard curves this would lead to a reduction in seismic loads by about 10% to 20%. For the hazard curves developed by WCFS, doubling the value of the hazard exceedance probability leads to a reduction of seismic loads in excess of 20%. In order to meet the intent of the guidance provided by Reference 5, it was concluded that SSCs could be considered acceptable without modification with HCLPF capacities equal to 80% of those required by the performance goals of [1]. For existing PC 3 SSCs, a HCLPF capacity of 0.25g corresponding to an annual probability of failure of 2.0×10^{-4} can be considered acceptable

PASSIVE SAFE SHUTDOWN:

Table 3 provides a summary of all components necessary to achieve a passive safe shutdown with associated HCLPF capacities. From this table, it can be seen that the HCLPF capacities for the required systems are: 0.44g for the PF-4 structure: 0.28g for the air intake system, 0.20 g for the exhaust filter plenums; and, 0.12g for the ductwork. From these values, the plant level HCLPF capacity is 0.12g and is controlled by the seismic stops on the fans for the exhaust ductwork. The annual probability of failure associated with the plant level HCLPF is 9.29×10^{-4} which does not meet the criteria for existing PC3 SSCs.

Upgrades have been designed and are currently being implemented for the seismic stops as well as the Zone 1 Exhaust Plenum which will raise the plant level HCLPF of the Passive Safe Shutdown SSCs to 0.28g (controlled by the Ductwork). The annual probability of failure associated with a HCLPF capacity of 0.28g is 1.35×10^{-4} and meets the criteria for existing PC 3 SSCs.

MONITORING FILTERED RELEASES

The systems necessary for monitoring filtered releases from the stacks include stack monitors, data acquisition and uninterruptable power supply. Table 4 provides a summary of all components necessary to monitor stack releases. From this table, it can be seen that the HCLPF capacities for the required systems are: 0.27g for the stack monitors; 0.05g for the data acquisition; and 0.05g for the uninterruptable power supply. The plant level HCLPF for monitoring filtered releases is 0.05g. The annual probability of failure associated with this capacity is 3.54×10^{-3} which is below the criteria for existing PC 3 SSCs.

Minor upgrades to the data acquisition and uninterruptable power supply systems would increase the plant level HCLPF for the monitoring systems to the acceptable performance goals.

OTHER SYSTEMS

Auxiliary Power System: From Table 5, the system level HCLPF for the auxiliary power system is 0.08g. The annual probability of failure associated with this capacity decreases to 1.84×10^{-3}. This system does not meet the requirements for existing PC 3 SSCs.

Primary Containment SSCs: Glove boxes, vault storage racks and process vessels were evaluated as they provide primary containment of hazardous materials. These SSCs were evaluated using bounding case samples to develop representative HCLPF capacities. The capacities for the components evaluated are shown in Table 5. For glove boxes, the limiting HCLPF capacity is 0.13g. For vault storage racks, the limiting HCLPF capacity is 0.12g. For process vessels (pencil tank farms), the limiting HCLPF capacity is 0.07g. The annual probabilities of failure for these HCLPF capacities are below the requirements for existing PC 3 SSCs.

Fire Suppression System: Establishment of a plant level HCLPF of the fire suppression system was beyond the scope of this evaluation. The main supply line which provides fire suppression water to PF-4 also supplies structures at TA-55 that are not part of the scope of this evaluation. Should damage to distribution lines in these other structures occur, water to PF-4 may not be available. However, two HCLPF values are determined for two subsystems which are part of the fire suppression system at TA-55. The first HCLPF is for the fire water storage tanks and

Table 3
HCLPF Capacity and Annual Probability of Seismic Induced Failure
Passive Safe Shutdown SSCs

Function	Structure System or Component	PC	HCLPF (g)	Criteria Met	PF (β=0.4)
Maintain		3	0.12	No	9.29E-04
Confinement	PF-4 Structure	3	0.44	Yes	3.16E-05
	Walls		0.49		
	Roof Diaphragm		0.44		
	Floor Diaphragm		0.49		
	Air Intake	3	0.28	Yes	1.35E-04
	Intake Valves		0.30		
	Intake Plenums		0.46		
	Intake Ductwork		0.28		
	Exhaust Plenums	3	0.20	No	3.19E-04
	Zone 3 Exhaust Plenum		0.46		
	Zone 2 Bleedoff Plenum		0.46		
	Zone 1 Exhaust Plenum		-		
	Plenum		0.20		
	Masonry Walls		0.63		
	Exhaust Ductwork	3	0.12	No	9.29E-04
	Zone 2 and Zone 3 Ductwork		0.28		
	Zone 1 Ductwork		1.50		
	Fans		0.12		

Table 4
HCLPF Capacity and Annual Probability of Seismic Induced Failure
SSCs Necessary for Monitoring Filtered Releases

Function	Structure System or Component	PC	HCLPF (g)	Criteria Met	PF (b = 0.4)
Monitor Filtered		3	0.05	No	3.54E-03
	Stack Monitoring System	3	0.27	No	1.49E-04
	Stack Fixed Head Filter		>0.50		
	Flow Transmittor		>0.50		
	Emergency Vacuum Pump		0.27		
	Stack Alpha CAM		>0.50		
	Control & Data Acquisition	3	0.05	No	3.54E-03
	Field Multiplexing Units		0.15		
	Central Control Units		0.49		
	Control Room Multiplex		<0.05		
	Computer Processing Units		0.68		
	Control Room Structure		0.39		
	Control Room Ceiling		>0.50		
	Pedestal Floor		>0.50		
	Uninteruptable Power Supply	3	0.05	No	3.54E-03
	Battery Chargers/Inverters		0.35		
	Battery Bank and Rack		0.23		
	Static Semiconductor Switch		>0.50		
	AC-Bypass Switch		<0.05		
	UA-Distribution Panel		>0.50		

Table 5
HCLPF Capacity and Annual Probability of Seismic Induced Failure
Selected SSCs Necessary to Enhance Worker Safety (Ref. 9)

Function	Structure System or Component	PC	HCLPF (g)	Criteria Met	PF (b=0.4)
Auxilary Power		3	0.08	No	1.84E-03
	PF-8 Structure		0.32		
	750 kVA Diesel Motor Generator		0.28		
	200 Gallon Fuel Oil Day Tank		0.44		
	Air Intake and Cooling Unit		0.34		
	Battery Start Bank		0.73		
	Air Start Tank		0.39		
	Generator Control Panel		0.28		
	Field Multiplexing Units		0.15		
	Switchgear Cabinet		0.37		
	Breaker Battery Banks		0.14		
	North Substation		0.43		
	Emergency Motor Control Centers		0.08		
	Auto Transfer Switches		0.08		
Primary Containment	Glove Boxes & Trolley Tunnels	3	0.08	No	1.84E-03
	GB-1439		0.15		
	GB-420		0.08		
	GB-472A		0.08		
	GB-192		0.13		
	GB-126		0.10		
	GB-362		0.19		
	GB-460		0.08		
	Trolley Tunnel - Room 319		2.85		
	Process Vessels (Pencil Tank Farms)	3	0.07	No	2.24E-03
	DS Process Effluent Tanks (Vertical)		0.10		
	T Process Tanks (Horizontal)		0.07		
	Pencil Tank Farm (Vertical - Room 209)		0.10		
	Vault Storage Racks	3	0.12	No	9.29E-04
	Room 29 - Typical Racks and Drawers		0.12		
Fire Suppression	PF-4 Distribution	3	0.11	No	1.09E-03
	Fire Detection, Sprinkler Heads		> 0.50		
	Fire Water Piping		0.11		
	Halon Distribution		> 0.50		
	Halon Containers Operations Center		>0.50		
	Fire Water Supply	3	0.14	No	6.90E-04
	Storage Tank		0.14		
	Secondary Diesel Pump		1.50		
	Day Tank for Diesel Pump		0.79		
	Battery Start for Diesel Pump		1.00		
	Auto Start Switch		0.22		

associated SCCs in the pumphouses. The second is for the fire suppression SSCs inside of PF-4.

The HCLPF capacities for the SSCs associated with the fire suppression system are shown in Table 2.4.19. The HCLPF capacity for the fire water storage tanks and pumphouses is 0.14g with an annual probability of failure of 6.9 x 10^{-4}. For the fire suppression system inside PF-4, the HCLPF capacity is 0.11g with an annual probability of failure of 1.09 x 10^{-3}. Both of these values are below the criteria for existing PC 3 SSCs.

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